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Proceedings of the Maritime Provinces Regional Advisory Process on Eastern Nova Scotia Snow Crab Assessment

7–8 March 2007
Mic Mac Amateur Aquatic Club
Dartmouth, Nova Scotia

Paul Boudreau
Meeting Chair

Bedford Institute of Oceanography
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June 2007

Compte rendu de la réunion du Processus consultatif régional des provinces Maritimes sur l'évaluation du crabe des neiges de l'est du plateau néo-écossais

Les 7 et 8 mars 2007
Mic Mac Amateur Aquatic Club
Dartmouth (Nouvelle-Écosse)

Paul Boudreau
Président de réunion

Institut océanographique de Bedford
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juin 2007

Foreword

The purpose of these Proceedings is to document the activities and key discussions of the meeting. The Proceedings include research recommendations, uncertainties, and the rationale for decisions made by the meeting. Proceedings also document when data, analyses or interpretations were reviewed and rejected on scientific grounds, including the reason(s) for rejection. As such, interpretations and opinions presented in this report individually may be factually incorrect or misleading, but are included to record as faithfully as possible what was considered at the meeting. No statements are to be taken as reflecting the conclusions of the meeting unless they are clearly identified as such. Moreover, further review may result in a change of conclusions where additional information was identified as relevant to the topics being considered, but not available in the timeframe of the meeting. In the rare case when there are formal dissenting views, these are also archived as Annexes to the Proceedings.

Avant-propos

Le présent compte rendu a pour but de documenter les principales activités et discussions qui ont eu lieu au cours de la réunion. Il contient des recommandations sur les recherches à effectuer, traite des incertitudes et expose les motifs ayant mené à la prise de décisions pendant la réunion. En outre, il fait état de données, d'analyses ou d'interprétations passées en revue et rejetées pour des raisons scientifiques, en donnant la raison du rejet. Bien que les interprétations et les opinions contenus dans le présent rapport puissent être inexacts ou propres à induire en erreur, ils sont quand même reproduits aussi fidèlement que possible afin de refléter les échanges tenus au cours de la réunion. Ainsi, aucune partie de ce rapport ne doit être considéré en tant que reflet des conclusions de la réunion, à moins d'indication précise en ce sens. De plus, un examen ultérieur de la question pourrait entraîner des changements aux conclusions, notamment si l'information supplémentaire pertinente, non disponible au moment de la réunion, est fournie par la suite. Finalement, dans les rares cas où des opinions divergentes sont exprimées officiellement, celles-ci sont également consignées dans les annexes du compte rendu.

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SUMMARY

A two-day meeting was held in the Maritimes Region on 7-8 March 2007. The purpose was to review the scientific advice on the status of Snow Crab on the Scotian Shelf up to the end of 2006, and to evaluate the consequences of different harvest levels during the 2007 fishery on stock abundance and exploitation rate.

These proceedings document the presentations, record discussion and recommendations, and include written reports from the scientific referees, the agenda, and the participants.

SOMMAIRE

Une réunion de deux jours s'est tenue dans la Région des Maritimes les 7 et 8 mars 2007 pour examiner l'avis scientifique sur l'état du stock du crabe des neiges du plateau néo-écossais jusqu'à la fin de 2006 et pour évaluer les conséquences de diverses quantités éventuelles de captures dans la pêche de 2007 sur l'abondance et le taux d'exploitation du stock.

Le présent compte rendu fait état des exposés, des discussions et des recommandations auxquels cette réunion a donné lieu et il inclut les rapports écrits des arbitres scientifiques, l'ordre du jour et la liste des participants.

INTRODUCTION

A two-day meeting was held in the Maritimes Region on 7-8 March 2007, to review the scientific advice on the status of snow crab on the Scotian Shelf up to the end of 2006, and to evaluate the consequences of different harvest levels during the 2007 fishery on stock abundance and exploitation rate. It was pointed out that this is a scientific review meeting and not a forum to discuss management considerations.

The Chair, Paul Boudreau, opened proceedings by welcoming the participants and, in particular, the two external scientific reviewers, Drs. Peter Koeller and Robert Miller.

The context and overall process of the assessment framework review, as outlined in the Terms of Reference, were then presented. The Agenda was reviewed and accepted. The Terms of Reference (Appendix 1), Participants List (Appendix 2), and Agenda (Appendix 3) are attached.

The Chair noted that the working paper and the draft 2007 Science Advisory Report were available at the back of the room.

These proceedings provide brief summaries of presentations, discussions, and comments from the participants. The work of the authors has been reproduced with little or no editing.

After thanking Alan Reeves, the meeting rapporteur, the presentation of the working papers commenced.

SUMMARY OF PRESENTATIONS

Oceanographic Overview

Presentation Highlights

Dr. David Brickman, Department of Fisheries and Oceans (DFO), presented a summary of physical oceanographic conditions on the eastern Scotian Shelf in 2006, relative to historical trends.

The North Atlantic Oscillation index (NAO) in 2006 was below the long term average, but still within the extreme limits observed through the historical record.

Monthly air temperatures observed at Shearwater and on Sable Island were above average in 2006, for all months. The annual average wind stress measured on Sable Island was slightly below the climatological mean. The wind direction was more southerly than normal during spring.

The areal extent of sea ice area seaward of Cabot Strait was below average in 2006, and has been for 10 of the last 11 years.

July bottom temperatures on the eastern Scotian Shelf were slightly above normal in 2006, and limited data suggested that the annual peak in bottom temperatures was somewhat later than usual.

An index of snow crab habitat can be calculated from the areal extent with bottom water temperatures between -1° and 3°. This habitat index calculated for eastern Nova Scotia (ENS)

from summer research survey data was low for 2006, reflecting the high bottom water temperatures. Available data for bottom temperature where crabs were caught showed that a significant proportion of the crab catches were realized in bottom waters that were higher than the 3° cut-off for the habitat index. In general, bottom temperatures are seen to be increasing and more crabs are caught at these higher temperatures. Based on our knowledge of how changes in the NAO affect our local oceanographic conditions, the increase in bottom temperature on the eastern Scotian Shelf is consistent with the observed decrease in the NAO.

Discussions

There was some discussion on the background of the habitat index. It was developed for the Gulf of St. Lawrence, and efforts are now underway to test its applicability to the Scotian Shelf. It was pointed out that on the Scotian Shelf, temperature preference for snow crab range from 0° to 7°. With warming bottom temperatures on the Scotian Shelf, it may be useful to investigate the cut off temperatures for a habitat index in this environmental situation. The habitat index was never published or peer reviewed.

There was some discussion on the NAO and what might be controlling it. This question is beyond the scope of this report, but it would be worth doing some additional studies on the link between the NAO and snow crab biology. For instance, it maybe useful to do ten-year running mean of NAO for comparison with the observations of population numbers for this long-lived snow crab.

Dr. Brickman is involved in a study to collect information on water bottom temperatures using mini-loggers that can be attached to commercial traps. There was some minimal data available from the 2006 fishery, and all observed data from the mini-loggers showed greater temperatures than expected from the climatology model.

It was agreed that the collection of the real time data was important in supporting the modelling of the oceanography. There was a call for additional participants who would volunteer to place the mini-loggers on their gear.

Assessment of the Status of Eastern Nova Scotia's Crab Fishing Areas (CFAs) Snow Crab up to the end of 2006

Choi, J.S., and B.M. Zisserson. 2007. An Assessment of the Snow Crab Resident on the Scotian Shelf in 2006. DFO Can. Sci. Advis. Sec. RAP Working Paper 2007/12.

Abundance

Presentation Highlights

In northeastern Nova Scotia, the post fishery fishable biomass of snow crab in 2006 was estimated to be 720 t, which represents a decline of approximately 50% from 2005. The declines were evident in all areas in northeastern Nova Scotia.

In southeastern Nova Scotia, the post fishery fishable biomass was estimated to be 25.4 X 10^3 t, which represents a 10% increase from 2005. The majority of the increase was seen on the continental slope areas, as well as a slight increase in the Chedabucto Bay area.

In CFA 4X, the pre-fishery biomass was estimated to be 850 t, which corresponds to a decline of approximately 13.5% from 2005.

Discussions

An explanation was give on how the stations for the survey were identified. The spatial distribution in 2006 was the same as 2005, with stations selected pseudo-randomly within each 10 min by 10 min square. Every station had start and stop locations selected.

The total number of crab caught has increased, but the number of legal crabs is unchanged. There were a lot of small crab observed that are expected to recruit to the fishery in coming years.

There appears to be some correlation between crab type (size, sex) with bottom type, but water temperature is a better indicator of overall species distribution than is the available data on substrate type.

A question was raised about the sampling on the slope of the shelf and the importance of this area that is presently not well sampled by the fisheries. It was pointed out that the survey does cover the outer slope areas sufficiently for this analysis. There is limited tagging data presently available in this area and there may be opportunities for additional work in the future.

There was some discussion on the Kriging methodologies, in particular, with respect to the use of external drift to model and what weight was it given. For the results, it should not affect the biomass index at all, but it might give rise to slight changes in the biomass distribution. It was pointed out that although bottom type might be a useful input to the Kriging, the resolution does not currently exist to carry this out effectively.

A question was raised about the use of doing sensitive analyses to investigate any problems that might occur from using Kriging on a system that is essentially dynamic. It could be done, but the technique is generally used to set masks. The assessment is also dynamic. Some sensitive analyses were conducted and the methodology seems to work with a variety of model variations.

It was pointed out that in southeastern Nova Scotia, the increase in the biomass estimate from last year is not statistically significant.

Recruitment

Presentation Highlights

The modal size from the size frequency is used to distinguish the different instar stages. Moulting preference for the immature crabs may be determined by temperature, with more frequent moulting with warmer water temperatures.

The number of recruits in northeastern Nova Scotia is low with no sign of change over the last three years.

The number of recruits in southeastern Nova Scotia is showing a slight increase over 2005, although it is still very low compared to the late 1990's and early 2000's.

Discussions

With the warming of water temperatures, females may mate every year rather than every second year as they do now.

A question was raised about the available data sources for larval abundance and distribution. There are the larval surveys from the 1970's and the Continuous Plankton Recorder (CPR) data. In both cases, the species were only distinguished to Brachyuran level of taxonomy. It was pointed out that there has been some larval sampling conducted in Chedabucto Bay recently, but the data was not presented here.

A question was asked about, based on the available data, how strong is the expected recruitment pulse compared to last pulse? It is difficult to say. Before 2001, only core areas were surveyed, but now sampling is being carried out over a wider geographic area in an attempt to try to set bounds of distribution. This makes it difficult to compare results over the full time series.

There was a question on the impact of changes in the levels of predators on snow crab. Cod populations are low and skate populations are high. The exact relationship between the number of predators and recruitment of snow crab is hard to determine with only a three-year time series, but the general ecological scenario is positive for snow crab.

Exploitation Rate

Presentation Highlights

The numerical abundance estimates of carapace condition stage 5 (CC5) crab are close to being undetectable on the Scotian Shelf. Their low representation in survey data and the fishery-observed data may be indicative of high exploitation rates upon the hard-shelled phase.

Exploitation rate estimates from abundance estimates increased exponentially from 2001 to 2004, in northeastern Nova Scotia. Large reductions in Total Allowable Catch (TAC) were implemented for the 2005 and 2006 season, resulting in sharp reduction of exploitations rates from 47% to 27% by biomass. In 2006, the exploitation rate increased to 40%.

In southeastern Nova Scotia, the relative exploitation rate has been generally stable between 15 to 20%. In 2006, due to conservation concerns the exploitation rate was reduced to 13%.

In CFA 4X, exploitation rates have been comparable with those observed in southeastern Nova Scotia. In 2005, the exploitation rate was 21%.

Commercial Catch Rates in the 2006 Fishery Compared to those in Previous Years

Presentation Highlights

In northeastern Nova Scotia, the 2006 catch rates were 35.6 kg/trap, a 16% increase from 30.6 kg/trap in 2005. This is mainly due to the movement of fishing effort away from areas of lower catch rates, such as the former CFA 20, to areas with higher catch rates, namely the Glace Bay Hole. In northeastern Nova Scotia, catch rates are still well below the ten-year mean.

In southeastern Nova Scotia, the 2006 catch rates were 90.6 kg/trap, a 17% decline from 109.4 kg/trap in 2005. These are the lowest catch rates in the five-year record. The spatial

distribution of catch rates was highest in the offshore areas and very low in most inshore areas. Peak levels were found towards the Misaine Bank and Sable Island areas of southeastern Nova Scotia.

Abundance of Female Crab from the Survey

Presentation Highlights

The numerical abundance of mature females are beginning to rapidly increase with newly matured females from the leading edge of the recruitment pulse and the continued longevity of the older mature females. Most of the mature females are currently located in the former CFA 23A and 24A, as well as, the Glace Bay Hole and the inner CFA 22. These were, therefore, the core areas where larval production was occurring.

Berried females have increased in recent years in all areas.

The number of females is very high at the moment and the distribution of males and females are coinciding better this year. It is expected that there will be recruits coming into the fisheries in future years.

Discussions

A question was asked about whether the increasing water temperatures might be impacting on the projected numbers of females. No data was available to address this question.

There was a question about the impact of the high female abundance on the population as a result of the balance between reproductive capacity and the pressure from cannibalism. It was pointed out that several studies and anecdotal information suggest females are aggressive cannibals on younger life stages and that this may contribute to cyclic levels of abundance. This might help explain why only very strong year classes survive to recruit to the fisheries. It is unknown exactly what the result of high female numbers will be on future fishable biomass.

There was a discussion on a possible reference point for the sex ratio of the population. An old male can service 4-5 females. There was no information presented on an acceptable reference point.

It was pointed out that it is unclear whether there is any relationship between seismic activities and periods of low female abundance. The Gulf Region is continuing to study possible seismic impacts.

Although females are not known to be entering the traps, there may be bottom trawling in the areas occupied by berried females. There is a question about shrimp draggers operating over areas with females and white-shelled crab (newly hardened carapace) that could be having impacts. It was suggested that fishing effort of shrimp drags be plotted over the location of berried females and white-shelled crab to investigate any possible overlap. There may be some potential for cooperation amongst fishers of shrimp and snow crab in studying this question.

Fishing Effort Distribution in the 2006 Fishery

Presentation Highlights

In 2006, the fishing effort was less spatially constrained. The spatial distribution of fishing effort continued the trend of increasing effort in midshore areas and declines in the inshore areas and Sable Island area's offshore. In northeastern Nova Scotia, total effort in the Glace Bay Hole area increased. In southeastern Nova Scotia, the majority of the fishing effort was observed north of Sable Island, southeast of French Bank, northeast of Middle Bank, and south of Misaine Bank.

Relative to 2005, the spatial distribution of fishing effort was more constrained to a smaller core area offshore areas in southeastern Nova Scotia. This shift may have in part been encouraged by increased trap limits in CFA 23. In CFA 4X, the majority of fishing effort continued to be centered south of Sambro.

In 2006, a calculated total of approximately 13,700 and 49,000 trap hauls were applied in northeastern Nova Scotia and southeastern Nova Scotia, respectively. Relative to 2005, this represents a decline of 26 and 15%, respectively, due in part to reduced TACs in all CFAs.

Discussions

It was noted that commercial catch rates are not representative of abundance. Catch rates might be able to tell something about some aspects of the population. The scientists' job is to attempt to determine the exact nature of the relationship.

A question was asked about the timing of the fishery. In the Gulf Region, some fisheries management units wait until June before the fishery starts to avoid the mating period. It was pointed out that there are different environmental conditions on the Scotian Shelf and this affects the timing of mating and moulting making the two situations incomparable.

Soft-Shelled Crab Catches in the 2006 Fishery

Presentation Highlights

For northeastern Nova Scotia, the occurrence of soft-shelled crab in 2006 was lower than that observed in 2005. The geographic distribution of catches of soft-shelled crabs changed from the former CFA 21 in 2005, to be centered in the former CFA 22-1 in 2006.

Soft-shelled crab incidence occurred in low and high catch areas.

In southeastern Nova Scotia, the incidence of soft-shelled crab catches were higher in 2006. The observed incidence of soft-shelled crab was distributed throughout the fishing grounds with the exception of the area east of French Bank.

There is a problem with elevated mortality in soft-shelled crab associated with handling and discarding. This is believed to have a direct deleterious effect on the fishable biomass of crab in future years. The voluntary soft-shell crab protocol attempts to reduce this impact and should be continued.

Discussions

A question was asked about the legal requirement of fishers to retain pencil-clawed crabs if they are over the commercial size limit. It was clarified that there was a voluntary clause in the license that would allow fishers to return pencil-clawed crabs to the water without penalty. It was pointed out that there is a need to protect pencil-sized crabs because they grow very quickly and will be caught in the future.

There was a question about why soft-shelled crab discard rates were higher in 2006, compared to 2005. This may be the result of the new voluntary soft-shell protocol.

Evaluate the Consequences of Different Harvest Levels During the 2007 Fishery on Stock Abundance and Exploitation Rate

Presentation Highlights

The long-term, forward-thinking precautionary approach adopted by the southeastern Nova Scotia fishers over the past three years, has allowed the southeastern Nova Scotia fishers to bridge the recruitment gap that has lasted for more than five years on the Scotian Shelf. Now, with the pending recruitment pulses nearing full entry into the fishable biomass, and with large numbers of females having had the opportunity to mate with larger and older males, the health of the southeastern Nova Scotia stock can be said to be back on a positive direction. For the first time since 2001, an increase in fishable biomass has been observed and a strong and steady recruitment is expected for the next four to five years. Forecasts into the future indicate that there is a strong potential for this fishery for at least the next five years, but this strength will be dependent upon how aggressively it is exploited. Based upon the crude projection scenarios, maintaining an exploitation rate between 10 and 20% would provide the greatest longevity to the fishery. Ensuring the longevity of the fishable biomass is important as on the Scotian Shelf recruitment has so far occurred in pulses and not as a constant stream, such as is the case in the Gulf of St. Lawrence. A status-quo or a marginal increase in TAC is suggested.

In contrast, in northeastern Nova Scotia, the extremely high exploitation rates have pushed the fishable component of the northeastern Nova Scotia snow crab population to an historic low. They have not been able to "bridge" the recruitment gap. What will occur to the fishable biomass in 2007 is highly uncertain as the leading edge of the recruitment pulse is still another year away from entry into the fishable biomass. The reproductive females have mated, but the males that were there to mate were predominantly small, immature males. Associated female mortality may have been elevated as a consequence. Indeed, with the more depleted fishable biomass, the occurrence of soft- and white-shelled crab may also be expected to increase in northeastern Nova Scotia for 2007. Projections of fishable biomass for northeastern Nova Scotia suggest that exploitation at current rates of 40 to 50% are unlikely to help maintain the longevity of a strong fishable biomass. A reduction in TAC is suggested.

In area 4X, exploitation rates have been comparable to that of southeastern Nova Scotia, near 20%. If maintained at this level, the 4X population may be following a trajectory similar to that of southeastern Nova Scotia. However, large inter-annual temperature variations in the area increase the uncertainty associated with these scenarios. The 4X snow crab population exists in a state intermediate between northeastern and southeastern Nova Scotia in terms of the five-year population trends. This is the case, even though they are the southern-most population existing in a more "marginal" environment relative to the "prime" areas of northeastern Nova

Scotia. Until the 4X fishery is completed, it is not yet possible to provide any clear advice for this area.

The longevity of the fishable biomass can be improved by fishing solely upon morphometrically mature crab. The arguments for this approach are as follows:

- Fishing mature crab would allow them to mate as the fishing season is post-mating season. This has the important result of reducing Darwinian selection for early maturation which is a long-term hazard for any fishery that harvests immature individuals.

- The capture of immature crab ("pencil claws") reduces the longevity of the fishable biomass directly relative to a mature-only fishery. The time difference is two to three years as immature crab go through a soft- and then white-shelled phases that exclude them from the fishery. Specifically targeting mature, male CC3, and CC4 crab would be a more optimal exploitation strategy.

- There is a significantly large weight increase if immature crab are allowed to grow and mature.

In the 2007 season, much of the fishable biomass may be composed of immature individuals. Excessive fishing of this component of the fishable biomass is unwise.

High catches of soft-shelled crab will likely continue to be a major issue for the next 3-4 years. Timely responses from industry to avoid fishing in areas showing potential or actual high incidence of soft crab must continue if unnecessary mortality of future recruits is to be averted.

Discussions

A question was asked about exactly how large can we expect this latest recruitment pulse to be relative to the last pulse. The 2006 peak in numbers of crabs with 54 mm carapace width in the south is most likely higher than the peak that was seen in 1998, because the more recent surveys cover a broader geographic area with lower density, as attempts were made to collect information to quantify the area extent and edges of the snow crab biomass.

Estimate By-catch of Non-Snow Crab Species from the Past Three Fishing Seasons

Presentation Highlights

By-catch levels in the snow crab fishery are low and are dominated mostly by other crab species. Over the past three years, by-catch levels were approximately 0.025% of the total landed biomass. This low incidence of by-catch is attributable to efficient trap design, large mesh, and the passive nature of the gear. Observers have reported three leatherback turtles entangled in buoy lines, however, all turtles were released with minimal or no damage.

CONCLUDING REMARKS

It was noted in the discussions that the work presented by Dr. Choi and his team was very well done. They were thanked for their excellent work.

The Chair reviewed the process to be followed for the remainder of the assessment framework review. The revised Science Advisory Report (SAR) would be submitted to the editorial board for final approval. Following translation, the SAR would be posted on the Canadian Centre for Science Advice website: http://www.dfo-mpo.gc.ca/csas/Csas/Home-Accueil_e.htm.

The Chair then thanked all the participants and closed the meeting.

REFERENCES

Choi, J.S., and B.M. Zisserson. 2007. An Assessment of the Snow Crab Resident on the Scotian Shelf in 2006. DFO Can. Sci. Advis. Sec. RAP Working Paper 2007/12.

APPENDICES

Appendix 1. Terms Of Reference

Science Advisory Process on Assessment for Eastern Nova Scotia Snow Crab

7–8 March 2007

Mic Mac Amateur Aquatic Club
Dartmouth, Nova Scotia

TERMS OF REFERENCE

Context

The snow crab fishery on the Eastern Scotian Shelf occurs annually during June to November, dependent upon the Crab Fishing Area (CFA). In support of the fishery, DFO Maritimes Fisheries and Aquaculture Management Branch requests Science Branch for an assessment of resource status and the consequences of various harvest levels for the coming fishing season. The current meeting is a scientific review of the assessment and projections undertaken in support of the 2007 fishery.

Objectives

- Assess the status of Eastern Nova Scotia's CFAs snow crab up to the end of 2006, using the following indicators:
  - Abundance
    - Snow crab survey biomass index of males greater than 95 cm (commercial sizes)
  - Recruitment
    - Snow crab survey R-1 relative abundance
  - Exploitation Rate
    - Incidence of CC5 crab in the survey
    - Relative exploitation rate from the survey
  - Report on:
    - Commercial catch rates in the 2006 fishery, compared to those in previous years
    - Abundance of female crab from the survey
- Evaluate the consequences of different harvest levels during the 2007 fishery on stock abundance and exploitation rate
- Estimate by-catch of non-snow crab species from the past three fishing seasons

Outputs

CSAS Science Advisory Report for Eastern Nova Scotia CFAs
CSAS Proceedings summarizing the discussion
CSAS Research Document

Participation

DFO Science Maritimes and Gulf Regions
DFO Maritimes Fisheries and Aquaculture Management
Provincial Government representatives
Industry
External reviewers

Appendix 2. List of Participants

Science Advisory Process on Assessment for Eastern Nova Scotia Snow Crab

7-8 March 2007

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Appendix 3. Agenda

Science Advisory Process on Assessment for Eastern Nova Scotia Snow Crab

7–8 March 2007

Mic Mac Amateur Aquatic Club
192 Prince Albert Road
Dartmouth, Nova Scotia

AGENDA

7 March 2007 - Wednesday

08:30–09:00	Welcome and Introduction (Chair)
09:00–09:45	Oceanographic Overview (D. Brickman)
09:45–10:15	The Fishery (B. Zisserson)
10:15–10:30	Health Break
10:30–10:45	2006 Snow Crab Survey (B. Zisserson)
11:00–12:30	Eastern Nova Scotia CFAs (J. Choi)
12:30–14:00	Lunch
14:00–15:00	Examination by Referees (Chair)
15:00–15:15	Health Break
15:15–16:30	General Discussion (Chair)

8 March 2007 - Thursday

09:00–10:00	Review of Science Advisory Report (Chair)
10:00–10:15	Health Break
10:15–12:00	Review of Science Advisory Report (Chair)
12:00 noon	Adjournment (Chair)